



# Admiral Johan Henrik Kreüger and his Anemometer

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The weather services of today were founded during the latter part of the 19th century, and much of the necessary preparatory work was performed by seamen. For example, although the 1806 wind scale of Admiral Beaufort was not the first one, it won general acceptance and still is used. It was first used by the captain of the **Beagle**, Robert FitzRoy, on his circumnavigation of the globe with Chales Darwin as naturalist. In 1854, FitzRoy founded the department of the Board of Trade, which later became the Meteorological Office. In 1861, he established a network of telegraphing meteorological stations and began reporting gale warnings and weather forecasts (a term he coined) to the public. His big "*Weather Book*" from 1863 shows our storms and cyclones as waves on the border between warm tropical and cold polar air.

In the 1840's, Captain Piddington introduced the notion of 'cyclone', and U.S. Admiral Maury's charts of the winds and currents of the major oceans in "*Wind and Current Charts* (1847)" revolutionized shipping. He also initialized the first international conference in oceanography, meteorology and navigation in Brussels in 1853.

Around 1850, Johan Henrik Kreüger, a weather-minded Swedish admiral, designed an anemometer. This instrument was used in the first Swedish network of meteorological observations, which was established by the

Swedish Pilotage Service around 1850. The network consisted of about 20 stations on Swedish beacons. The initiative came from the Royal Swedish Academy of Science (Erdmann 1855), and the primary purpose of the network was to study the postglacial land rise<sup>1</sup>.

Johan Henrik Kreüger was borne in Lovisa, Finland, 1782. His parents were the Customs Collector Johan Kreüger and wife Anna Cederhvarf. Though they did not belong to the nobility, at the age of 10 years Johan Henrik was appointed Sergeant in the Army's Fleet of Sveaborg. After having passed his examination as a naval officer as well as his examination in naval architecture, he was appointed Second Lieutenant in 1801. Most of the following 20 years he spent at sea, on warships and merchant ships. In 1812 he was appointed captain and sailed merchant ships to the Mediterranean and South America. During the Napoleonic war, he commanded warships. He was appointed Commander Captain in 1824, and the following year he became a member of '*Förvaltningen av sjöärendena*'<sup>2</sup>. He became head of the organization in 1841, when he was appointed Rear Admiral. He obtained the rank of Vice Admiral in 1850 and of Admiral in 1857. He became a member of the

	Wind pressure	Wind speed
Lab. Bram-segels Kultje	½	20
Bram-Segels Kultje	1	28.5
Frisk Bram-Segels Kultje	1½	35.5
Märssegels Kultje	2	41
Styf Mers-Segels Kultje	2½	46
Refvad Märs-Segels Kultje	3	50
Styf refv. Märs-Seg. Kultje	4	58
Under-Segels Kultje	5	65
Half Storm	7 à 8	79
Full Storm	10 à 12	96
Orkaner	20	130
Den starkaste Orkan som blifvit utrönt	30	159

**Table 1. The Swedish wind scale from 1779. Wind pressure in skålpund per Swedish square foot, wind speed in Swedish feet per second. 1 Swedish foot = 29.7 cm, 1 skålpund = 0.4251 kg. After Kreüger (1841).**

Royal Swedish Academy of War Sciences in 1817 and of the Royal Swedish Academy of Sciences in 1857, the year before his death.

After his time at sea, Kreüger became a diligent author on various subjects, such as naval history, present nautical and defence problems, and weapon development. In 1841, he gave a talk at the Royal Academy of War Science, '*Om Luften, dess rörelse eller Vindarne, samt orsakerna dertil*' ('About the Air, its Movements or the Winds and their causes'). In this speech he revealed his mastery of the meteorology of his time. He believed that the atmosphere could reach up to 90 km, and he knew that the air consists of 21 parts of oxygen and 79 parts of nitrogen. He was familiar

<sup>1</sup> 1858 the Academy started the first Swedish network for purely meteorological and climatological purposes, which 1859 had 21 stations and should increase to 30 stations.

<sup>2</sup> This government office managed the finances of the Navy and the lighthouses.



with the then new works of Redfield and Reid and knew that the devastating tropical storms (which we call tropical hurricanes) are rotating storms (anti-clock-wise in the northern hemisphere), and that although their wind speeds are very high, the systems themselves move much slower (10 to 30 nautical miles per hour). He knew their order of size and that the rotating tornadoes are much smaller. He also indicated that the storms of our latitudes may be rotating storms, perhaps originating in the West Indies. Later, data from his anemometer network convinced him that our storms are rotating (Kreüger 1855, 1857).

## An early Swedish wind scale

In 1779, a Swedish wind scale was developed during tests with a new Swedish 60 gunship (Kreüger 1841). The ship had an anemometer, a hand-held pressure plate of the type designed by Bouger (Middleton, 1969). In several cases the wind pressure was measured, and for each case the proper name of the wind was decided after discussion with all the officers. The scale is given in **Table 1**. The corresponding wind speeds were later calculated by Kreüger, (though he wrote that he could not guarantee their accuracy).

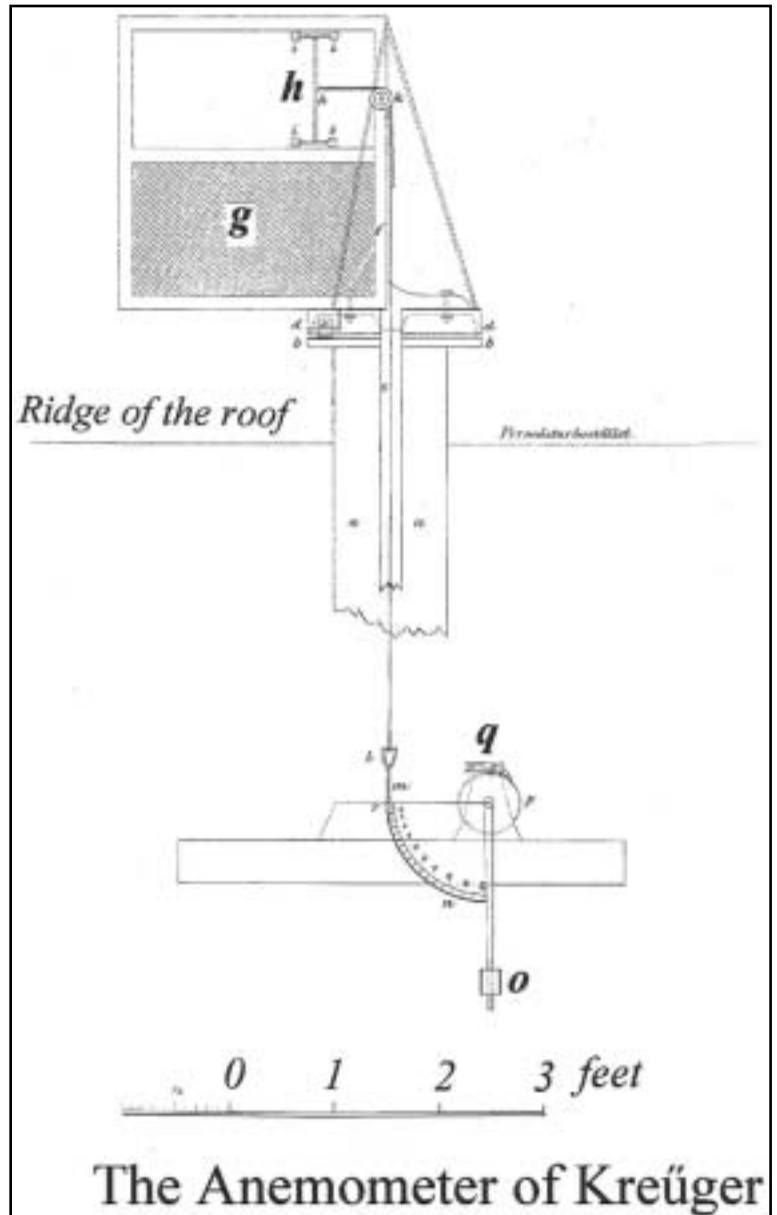
## The Anemometer of Kreüger

The pressure plate **h**, supported by two pairs of friction wheels, can move in a frame fastened to the wind vane **g**, **Figure 1** (Erdmann, 1855). The axis of the vane is a tube (Kreüger suggests a musket pipe). With a cord running in the tube, the pressure plate is connected to a lever with a scale and a counterweight **o**. Two clicks **q** lock the scale and counterweight at the maximum indication. The instrument thus records the maximum wind

pressure since last release of the clicks. After the first tests, the vane was equipped with a V-shaped fin to dampen its oscillations.

The sensors should be placed on the lighthouse master's house with the wind vane at the height of the chimney, and with the lever and the scale in the attic. A 32-point wind rose on the tube (not shown in **Figure 1**) showed the wind direction. The instrument also had a primitive recording device (not shown in **Figure 1**), a piece of chalk on the lever writing on a circular plate. A pendulum clockwork rotated the plate. This device was probably not used.

The anemometer took part in the world's exhibitions in London in 1851 and in Paris in 1855. In both of them, it won a medal. After a correspondence in which the Swedish King Oskar I took part, the instrument from the Paris exhibition was given to the French marine minister.



**Figure 1. The Kreüger anemometer. After Erdmann, 1855.**

A multitude of meteorological instruments were designed during the 18th and 19th centuries. Few of them were actually built and even fewer reached operational status. One of these is an anemometer created by the Swedish admiral Kreüger around 1850. It was used in the first Swedish network of meteorological stations, created about 1850. The main purpose of the network was to study the postglacial land rise, through several people, amongst them Kreüger himself, realised its possibilities.



In the early 1850's, the instrument was installed on nine Swedish beacons and on Kastellholmen, Stockholm, as well as on Kungsholm's fortress, Karlskrona. The observations were made three times a day, more often if the wind pressure exceeded a certain limit. A drawing from the latter half of the 19th century shows the anemometer at Holmögadd, **Figure 2**. The anemometer was used nearly 30 years. After a reorganisation in 1879, a new government office, 'Nautisk-Meteorologiska Byrån', took over the lighthouses, and the Kreüger anemometers were scrapped. They were replaced by a handheld manometer, the Hagemann's anemometer. This did not improve the wind observations; in fact they soon got worse, and the Hagemann anemometer was abandoned after about 20 years (Östman, 1928).

When the power of the wind is wanted, the wind pressure, not the wind speed, is the important parameter. Kreüger stressed the uncertainty in deducing the wind pressure from rotation anemometers. Kreüger's wind gauge and Robinson's cup anemometer were designed at about the same time, with Robinson's being designed somewhat earlier. The cup anemome-

ter is a mechanically much simpler and more elegant instrument, and Kreüger's pressure plate anemometer could not compete with it. However, his wind gauge was used for nearly 30 years in one of the earliest meteorological networks with anemometers. The lighthouses' meteorological journals from that period are stored in the archive of the Swedish Meteorological and Hydrological Institute.

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**Figure 2:** Holmögadd, latter part of the 19th century. Part from a drawing of an unknown artist. The anemometer is mounted on the roof of the lighthouse master's house, between the lighthouse and the flagstaff. A ladder against the gable is used to reach the attic and read the instrument. Observations were made 3 times each day, more often during high wind speeds. After Hedin, 1988.